THE WEATHER AND CIRCULATION OF JULY 1953[1]

HARRY F. HAWKINS, JR.

Extended Forecast Section, U. S. Weather Bureau, Washington, D. C.

DISAPPEARING DROUGHT

Last month was the second successive June with record breaking drought and heat [1]. Consequently, attention during July was focused upon the critical drought area. On July 6, the *Weekly Weather and Crop Bulletin* stated: "The drought is most severe in Arkansas, Oklahoma, and the extreme western and extreme southern portions of Texas where the total rainfall for the last 7 weeks was mostly less than 10 percent of normal." It was also extremely dry in Arizona and southern Utah where the usual summer "Arizona Rains" [2] had yet to make their appearance.

FIRST DECADE OF JULY

Although early July saw the intensification of heat and drought over the Southwest, by the end of the first decade some relief occurred. Figure 1 shows the 700-mb. contours together with the temperature and precipitation anomalies for the first 10 days of July. The mean heights (fig. 1-A) are similar to those for the month of June in the location of troughs off either coast of the United States and the high over the Lower Mississippi Valley. However, the weakening and filling of the west coast trough led to a less well-defined ridge system over the central United States. As a result, cold air began to penetrate this area via the Northern Plains, as might be expected from the strength of the western Canadian ridge.

Figure 1-B shows that for July 1–10 the mean temperatures averaged below normal as far south as central Kansas where June temperatures had averaged as much as 8° F. above normal. As the weakened upper level High began to split, this cooling proceeded southward reaching southern Louisiana by the end of the decade. Nevertheless, over much of the drought area temperatures averaged well above normal for this period.

Precipitation (fig. 1-C) shows the results of the weakening of anticyclonic circulation aloft and the renewal of frontal activity. In areas of convergence associated with the movement of fronts and cyclones sensible relief was effected mainly by shower activity. However, no measurable rain was recorded in extreme southern and extreme western Texas, eastern New Mexico, and southern Colorado, while precipitation was well below normal in the Lower Mississippi Valley. Summer showers in the Far Southwest started to become effective as the drought regime weakened. Ely, Nev., and Salt Lake City, Utah, reported over 200 percent and 175 percent, respectively, of the normal 10-day precipitation amounts. Figure 1-C

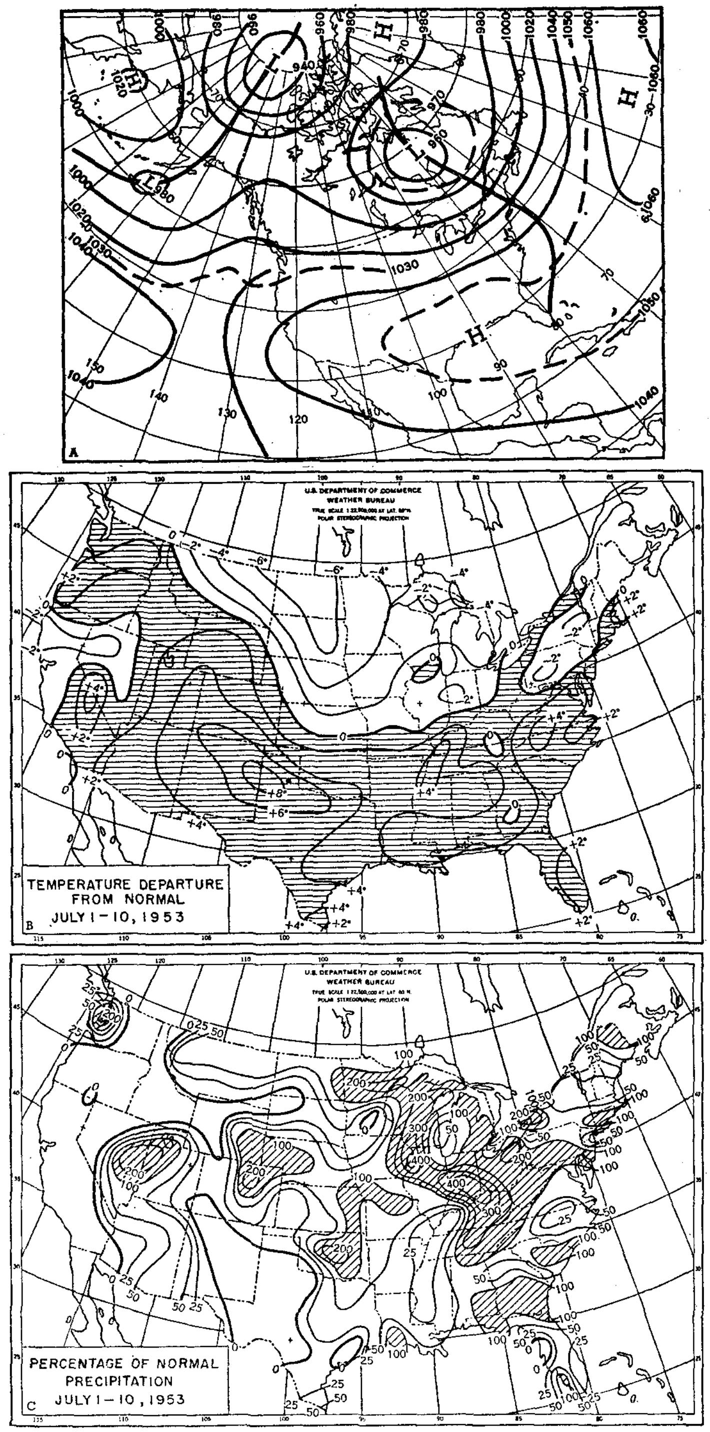


FIGURE 1.—Means for July 1–10, 1953. A. 700-mb. heights in tens of feet. Blocking in Bering Sea and cyclogenesis in the Gulf of Alaska led to filling of west coast trough and weakening of United States drought-producing ridge. B. Mean temperature departures from normal. Cooling has already invaded the Central Plains as United States ridge weakened. Drought area remained hot. C. Precipitation departure from normal showing the first significant precipitation of the mid-Plains and the initiation of the summer "Arizona Rains." Hatched area indicates areas with precipitation greater than 100 percent of normal.

[1] See Charts I–XV following page 216 for analyzed climatological data for the month.

is a good example of the complexity of summer precipitation patterns which reflect the showery nature of summer rainfall, the difficulties engendered by use of a relatively coarse rain gage network [3], and the employment of cumulative precipitation totals.

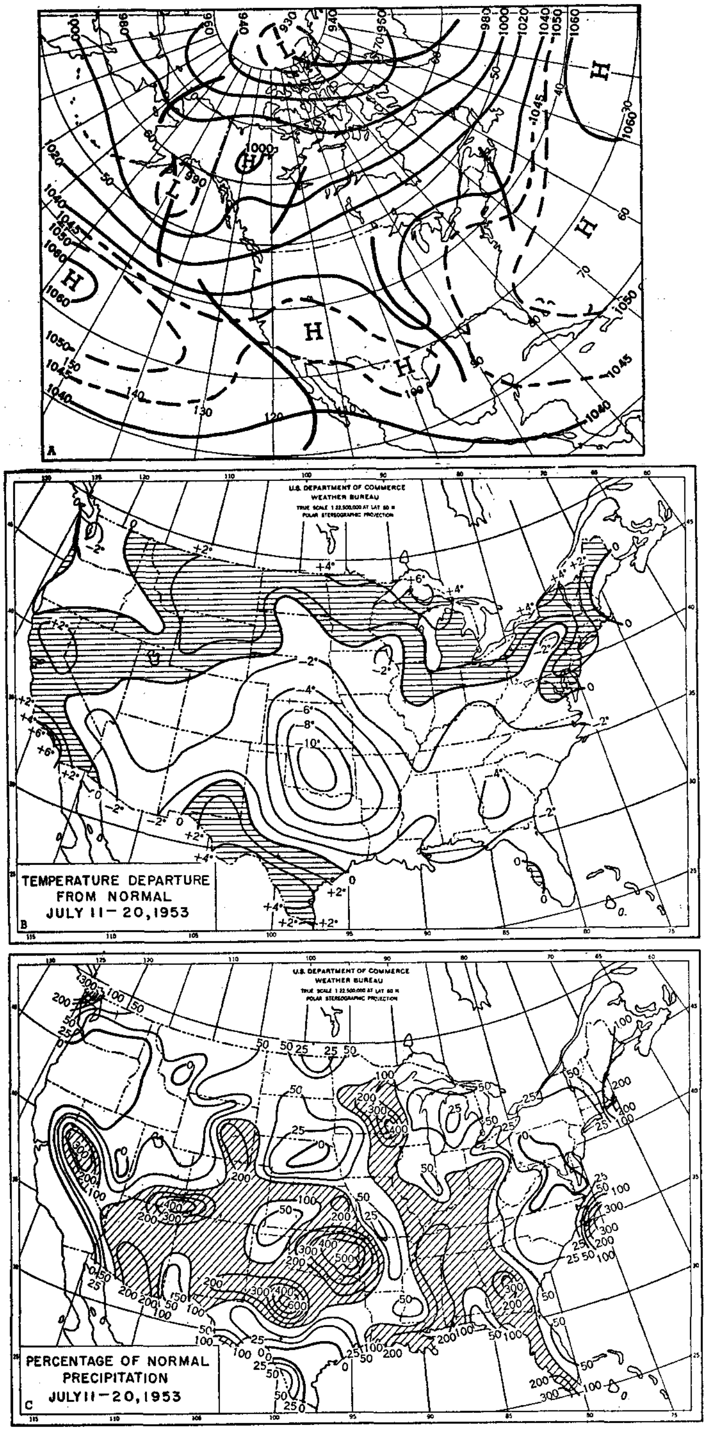


FIGURE 2.—Means for July 11–20, 1953. A. 700-mb. heights in tens of feet. Contours show trough development over central United States as west coast trough disappears. Note change in phase of westerly wave pattern from June [1] or figure 1-A and figure 3-A. B. Mean temperature departures from normal. Cool air dominates the Central Plains (in local reversal of June's heat) where cyclonic circulation aloft and persistent cloudiness prevail. C. Precipitation departure from normal. Continued drought relief over much of the Central and Lower Plains. Western showers continue. Virginia and North Carolina become increasingly dry under mean ridge.

SECOND DECADE

It was during the second decade of July that the most effectual relief arrived for the main drought areas. Figure 2-A shows the reversal of the 700-mb. circulation pattern when compared to June [1] or July 1–10 (fig. 1-A). The troughs off either coast weakened still further while the ridge formerly over the Lower Mississippi Valley was replaced by a marked trough over the Central Plains. This reversal in circulation was accompanied by pronounced cooling and fairly copious rainfall over large portions of the South Central Plains.

As shown in figure 2-B, Oklahoma, averaging 8° to 10° F. below normal, was the center of the cool anomaly. Below normal temperatures extended over the Central and most of the Southern Plains in a striking contrast to the heat of June and early July.

Precipitation was not everywhere abundant, but figure 2-C shows significant relief over most of the drought area. These rains, the result of frontal and air mass shower activity, were accompanied by considerable cloudiness which was an important factor in the below normal temperatures noted in figure 2-B. Continuation of shower activity over Arizona and adjacent regions restored most ranges to something approaching normal conditions. In spite of this, the persistent vagaries of summer showers left significant areas of the Panhandle, southern Texas, and southern Missouri-northern Arkansas critically dry.

Less fortuitous was the location of the mean ridge over the central Appalachians (fig. 2-A). This feature precluded sizable precipitation amounts over central areas of southern Virginia and North Carolina. Precipitation totals in these regions were from 0 to 10 percent of the normal amounts. Four-week precipitation totals (preceding July 20) were only 20 to 50 percent of normal. Rainfall deficiency plus normal July heat were establishing a new drought area. In fact, practically all miscellaneous crops in the Atlantic Coastal region from South Carolina to New York were reported suffering from lack of rain.

THIRD DECADE

As shown in figure 3-A, during the third decade there was a definite tendency for return of the circulation to a pattern like that of June and earlier July. The High once more became established over the southern Mississippi Valley after the mid-United States trough had worked its way eastward to the Atlantic Coast. The lower extremity of this trough trailed back toward the Delta region while the northeastern Gulf of Mexico was the scene of several (westerly moving) easterly waves.

In figure 3, sections B and C show the effects of this transition upon the anomalies of temperature and precipitation. Warming was slow over the South Central and Southeastern States with the 10-day averages near, to below, normal. The anticyclonic circulation of continental air resulted in above normal temperatures from the Central Plains eastward to Virginia and North

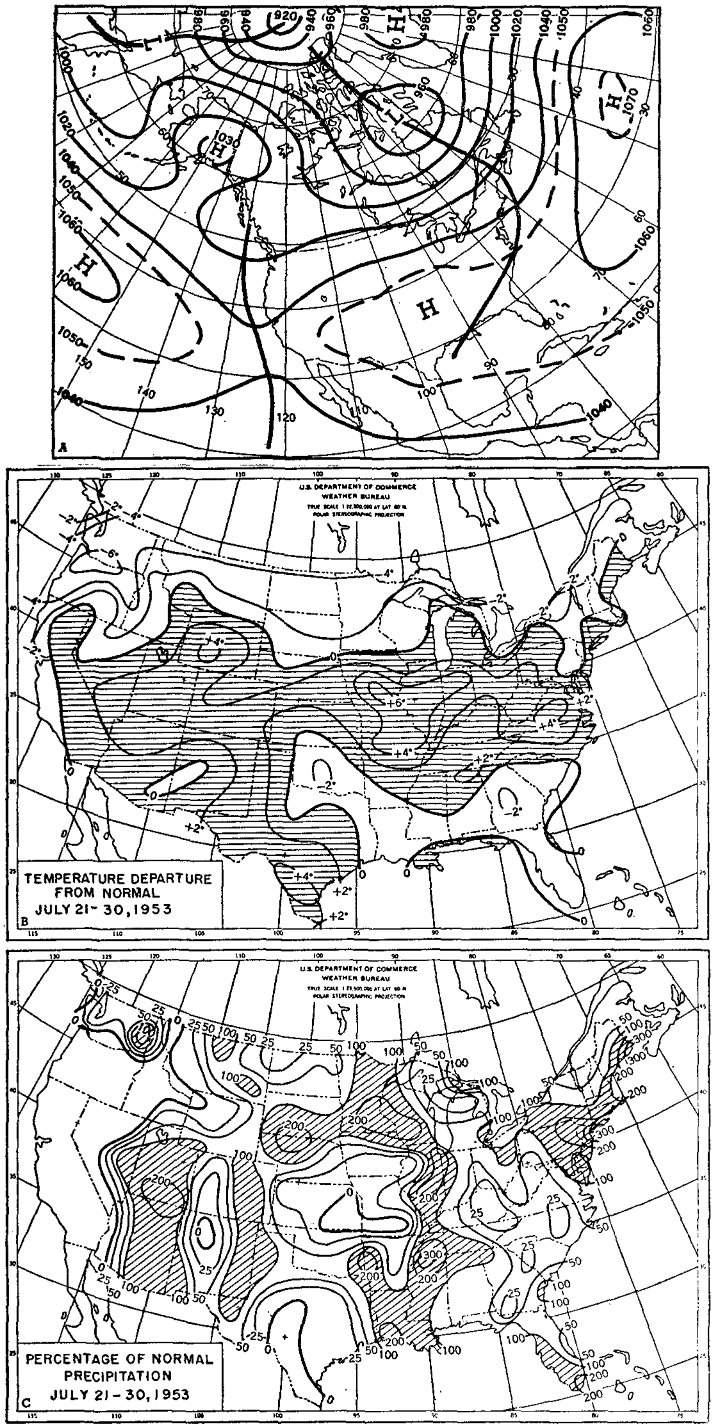


FIGURE 3.—Means for July 21–30, 1953. A. 700-mb. heights in tens of feet. Return to previous 700-mb. circulation pattern as central United States trough (fig. 2-A) moved east. B. Mean temperature departures from normal. Slow warming in southern Plains, continued heat in the mid-Appalachians. C. Precipitation departure from normal. Decreasing precipitation in southern Plains as pattern reverted toward that of June. Rains from Mississippi River to Appalachians occurred early in period as trough moved eastward. Continued rains over western ranges.

Carolina. During all three of these periods southern Texas averaged above normal and the monthly positive departure there (see Chart I) was the largest in the entire United States.

Ten-day precipitation anomalies (fig. 3-C) also reflect this transition in circulation pattern. The Central Plains received less than 25 percent of normal rainfall. Precipitation between the Mississippi Valley and the Appalachians was almost entirely an early period occurrence, most of the rain falling as the mid-United States trough (fig. 2-A) migrated eastward. Unfortunately, the trough accelerated as its downstream profile flattened during its traverse of the central Appalachian region. Consequently no real relief was provided the needy Virginia-Carolina area. Virginia pastures were reported in the poorest condition since 1930 and corn was stunted; much of North Carolina was also hard hit with Raleigh and Greensboro reporting the driest July on record. Through all these variations southern Missouri received little or no precipitation. Along with southern Texas it made up what remained of the original "disaster area" and they now shared attention with the southern Virginia-North Carolina sections.

In the Far Southwest, shower activity continued as the upper level High supplied tropical moisture from the Gulf and the "Arizona Rains" [2] held sway. The main exceptions were western New Mexico and southwestern Colorado. Many of these sections on the eastern Colorado Plateau received less than 25 percent of the normal 10-day precipitation.

In summary, most of the original drought area received fairly effective relief in July. Both rainfall and temperature were more favorable for farming over the greater part of the once-striken area. The relief was not 100 percent effective and in the course of the alleviation a new area of suffering was created. This is not surprising since in a country with the longitudinal dimensions of the United States, i. e., spanning a full wave length of the westerlies, it seems almost axiomatic that persistence in circulation patterns will lead to opposite extremes of anomalies.

MONTHLY CIRCULATION FEATURES

The average 700-mb. circulation pattern for the month (fig. 4) shows a rather poorly defined westerly wave pattern. Both of the troughs which normally affect the United States (off either coast) were extant but each was weaker than normal with heights about 70 feet above average. The central United States trough of the middle decade (fig. 2-A) had its counterpart in the mean monthly trough of the same area, i. e., the split in the subtropical high cells. The Pacific pattern was relatively flat at middle latitudes with the largest anomaly (+300 ft.) of the month located over Bering Sea—a result of strong blocking activity during the first half of the month (fig. 1-A). It appears that this early blocking and the typical cyclonic intensification to its southeast can be readily associated with the filling of the west coast trough and may, therefore, be a teleconnection in the breaking of the United States drought.

An integral part of this pattern was an unusually strong polar vortex. This center of action was a per-

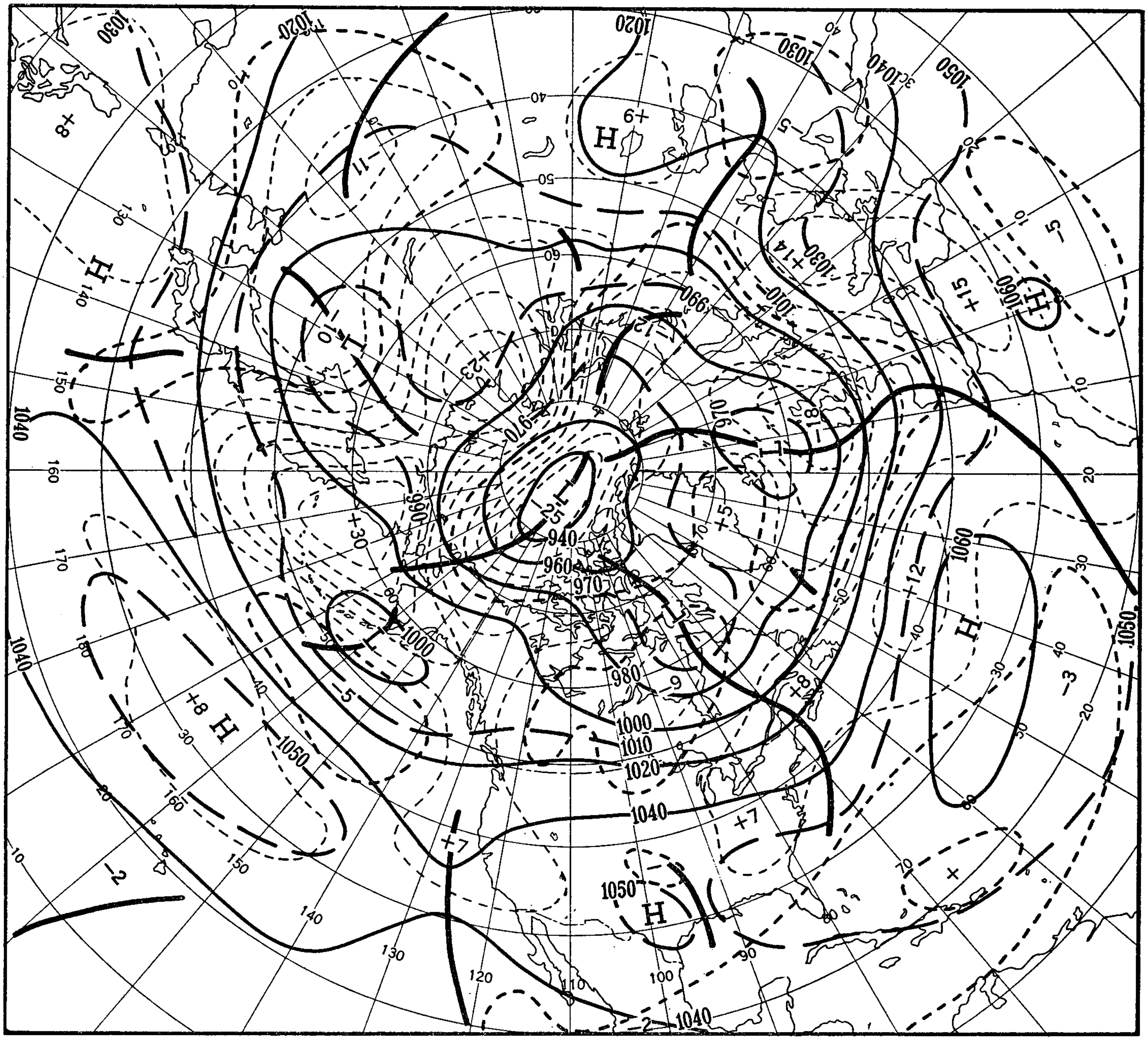


FIGURE 4.—Mean 700-mb. height contours and departures from normal (both in tens of feet) for June 30–July 29, 1953. Weakening and splitting of subtropical anticyclone over south-central United States (see June 1953 [1]) and poorly defined coastal troughs were indicative of transitions. Well developed Arctic vortex (−250 ft.) and Bering Sea blocking (+300 ft.) were major abnormalities in otherwise flat pattern.

sistent abnormal feature of the month's circulation. The 250-foot departure from normal associated with it was the largest negative anomaly on the map. These high latitude vortices are important features of the circulation since their extension into and connections with the mid-latitude westerly wave train usually have immediate effect upon the train itself.

Very similar features can be noted at the 200-mb. level (fig. 5). Most of the 700-mb. characteristics were readily identifiable at this (40,000-foot) level. The striking exceptions were the disappearance (or tremendous displacements) of the subtropical oceanic anticyclones at higher levels. Geostrophic wind speeds (isotachs dashed in fig. 5) at 200 mb. showed a well marked, almost zonal, wind speed maximum which was located between 40° and 45° N. over most of the Pacific and between 45° and 50° N. elsewhere. The United States and Atlantic sectors of the maximum were in good agreement with the "normal" location of the jet stream [4]. However, the Pacific maximum appeared to be slightly farther north than "normal" with two centers of maximum velocity separated by the longitudes most affected by blocking. To the north, an Arctic maximum was clearly discernible between 70° and 75° N.

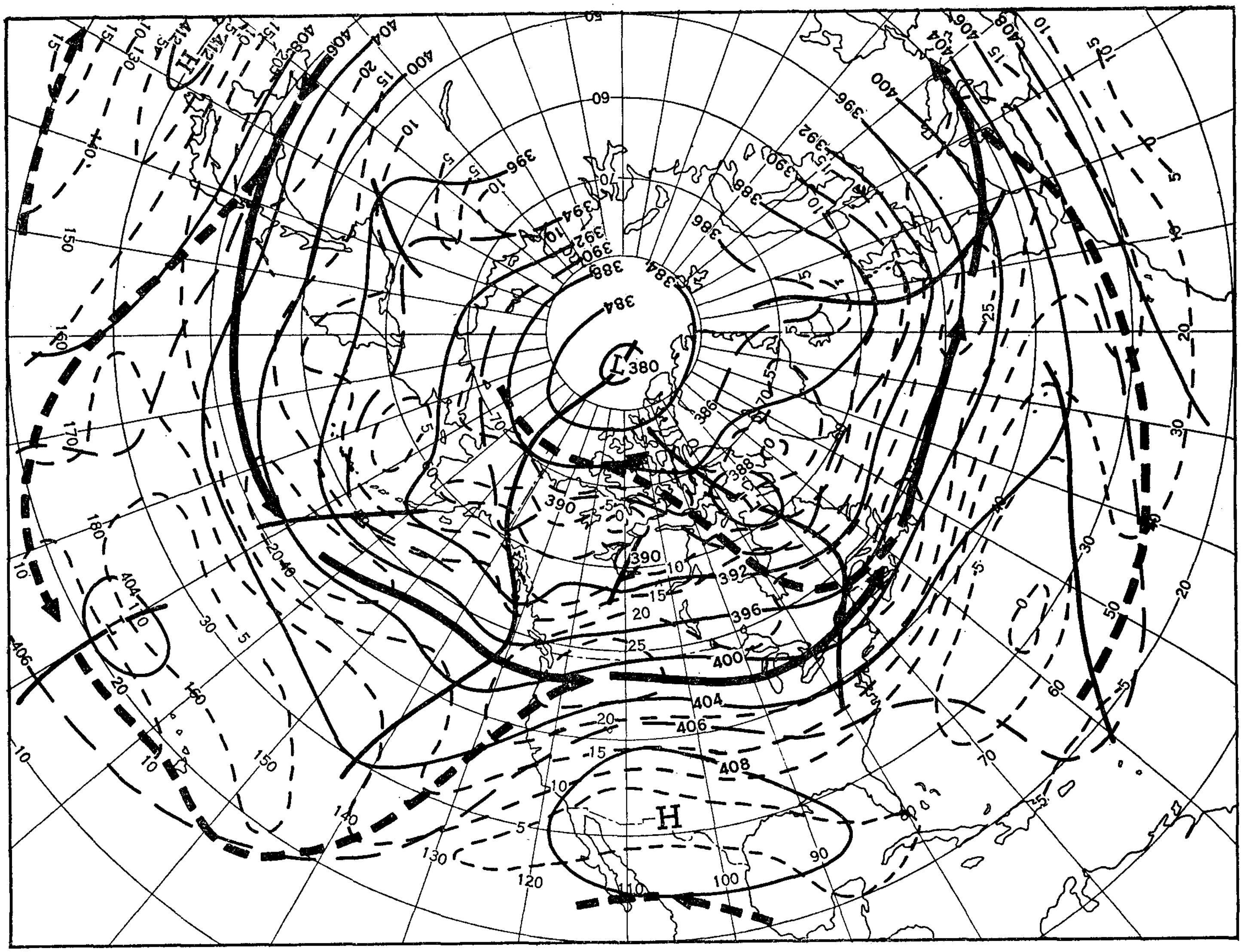


FIGURE 5.—Mean 200-mb. contours (in hundreds of feet) and isotachs (in meters per second). Well-developed west wind maximum extended from Japan to Europe at about 45° N. Arctic maximum indicated in polar latitudes. Note troughs above mid-oceanic Highs in Tropics (fig. 4).

CYCLONES AND ANTICYCLONES

The depression of the Pacific cyclone tracks by blocking is evident in figure 6-A where very few storms can be noted in their usual rendezvous, the Bering Sea. During much of July, the Gulf of Alaska and adjacent regions served this purpose while blocking Highs dominated the Bering Sea. Further evidence of this displacement can be found in the monthly mean sea level map and its departure from normal, Chart XI. Pressures averaged 4 mb. below normal just south of the Gulf of Alaska, and 7 mb. above normal in the western Bering Sea. Arctic cyclones associated with the polar vortex are also indicated both on the track map and the sea level departure from normal which averaged 11 mb. below normal at the Pole (not shown).

The major North American storm track lay about 10° north of the west wind maximum (fig. 5). Most of the trajectories were of a zonal west-to-east nature in accord with the flat 700-mb. flow pattern. Minor secondary developments on trailing fronts were fairly numerous east of the Continental Divide but a number of them dissipated more or less *in situ*. With fast, flat westerlies on across the Atlantic (fig. 4) many of the perturbations of eastern Canada travelled rapidly across the Atlantic in the well-marked channel north of the maximum westerly winds.

Anticyclonic intrusions into the United States were quite frequent for July. These Highs showed a marked preference for invasion of the United States through the Northern Plains usually turning southeastward through the Eastern Lakes. When the polar vortex was strong, surges of mP air entered western Canada and drifted southeastward as indicated in figure 6–B. Following the peaks of Arctic activity, anticyclones of Arctic origin passed eastward or southeastward along one of the branchings indicated in the far north. Only occasionally did the

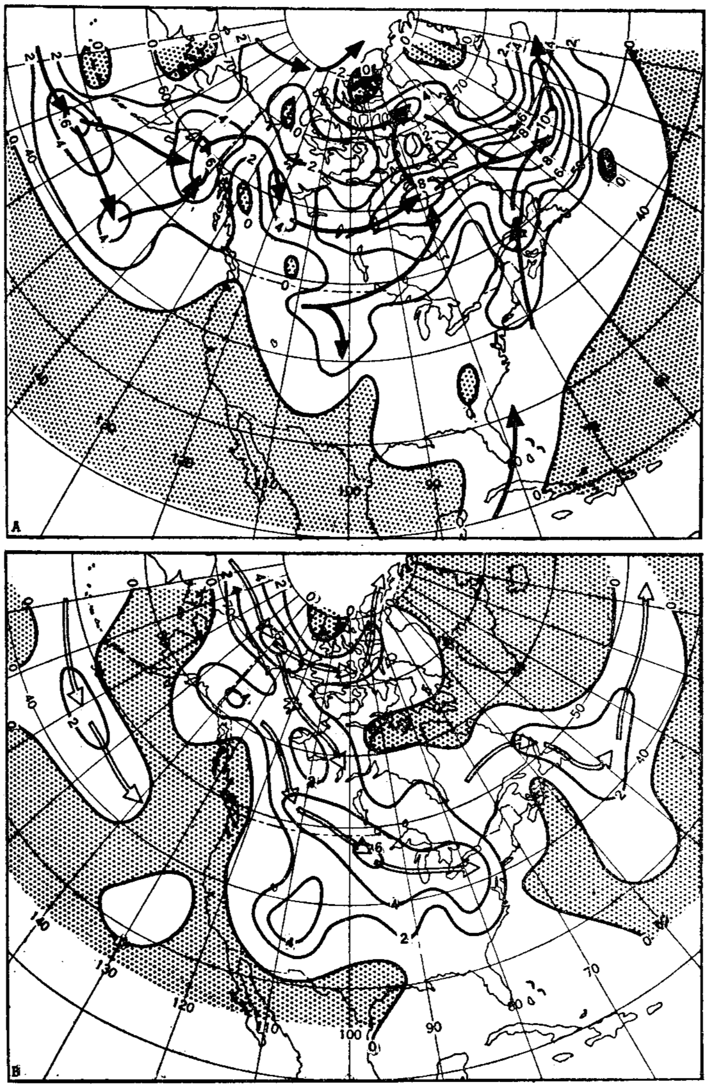


FIGURE 6.—Frequency of cyclonic passages (A) and anticyclonic passages (B) (within 5° squares at 45° N.) during July 1953. A. Depressed cyclone track in Pacific indicative of blocking. Zonal motion of cyclonic centers over eastern North America and Atlantic agree with flat, fast flow of figures 4 and 5. B. Note frequent intrusions of Pacific and Arctic Highs into United States and Canada.

Highs arriving in the eastern United States pass off the coast as closed centers. The others either stalled under the mean ridge over the Appalachians or deteriorated into weak eastward moving pressure surges.

TEMPERATURE AND PRECIPITATION

Charts I, II, and III present the mean monthly temperature and precipitation data. Below normal temperatures throughout most of the Plains and precipitation mainly between 50 and 100 percent of normal sum up the story of drought relief. Southern Texas remained hot and dry under the small upper-level Texas anticyclone shown in figure 4. Temperatures in the West under the 700-mb. ridge were appreciably above normal despite normal to greater-than-normal shower activity over much of the area. This apparently came about when the depression of the maxima due to daytime cloudiness was not as great as the elevation of the minima associated with the moisture and nighttime cloudiness.

Precipitation in the Upper Mississippi Valley resulted from convective showers plus those induced along the cold fronts of impinging cold air masses and occasional squall lines. Drought conditions in Virginia and North Carolina were associated with the positive height anomaly center over the Appalachians. Positive precipitation centers of note occurred in the northeast coastal area near the mean trough, the Far Northwest where trailing fronts of perturbations entering Canada from the Pacific caused showers, and those areas of the South and West already discussed in the detailed 10-day descriptions.

WEATHER VAGARIES

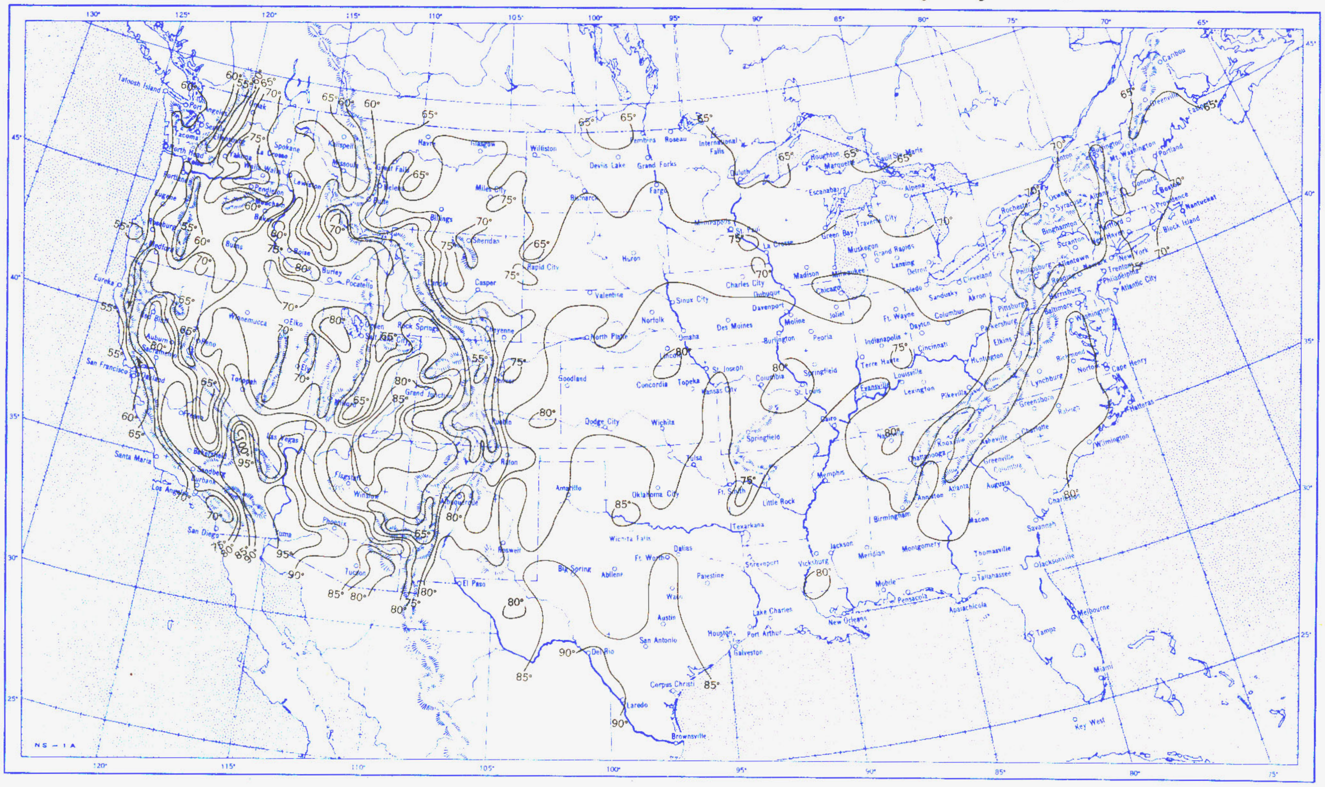
As usual the more whimsical digressions of weather made news this month too. These ranged far in distance and were varied in subject. Items: Snow plows were busy in the Italian Alps after a rare summer snowstorm of 2 to 3 inches (A. P., July 11); dust rising to 35,000 feet some 200 miles west of Tucson, Ariz., lent an odd greenish appearance to the sun which went through surprising (apparent) gyrations as an inversion layer was disturbed (A. P., no. date); Philadelphia, Pa., set a new daily maximum record of 99° F. on July 18, and 1 week later a new daily low (60.6° F.) on July 25; less meteorological but more refreshing was the all-time (since 1912) record surface water temperature of 81° F. recorded at Atlantic City, N. J., on July 22.

Not to be considered whimsical, however, were the floods—the worst in modern Japanese history—which occurred some 200 miles southwest of Tokyo about the 19th of July. Sudden cloudbursts and continuing heavy rains left more than 6,000 persons dead or missing and engulfed entire villages. Kyushu, recovering from the catastrophic floods of 3 weeks earlier which had left more than a million homeless, was also affected and reported waters rising again in debris-filled cities.

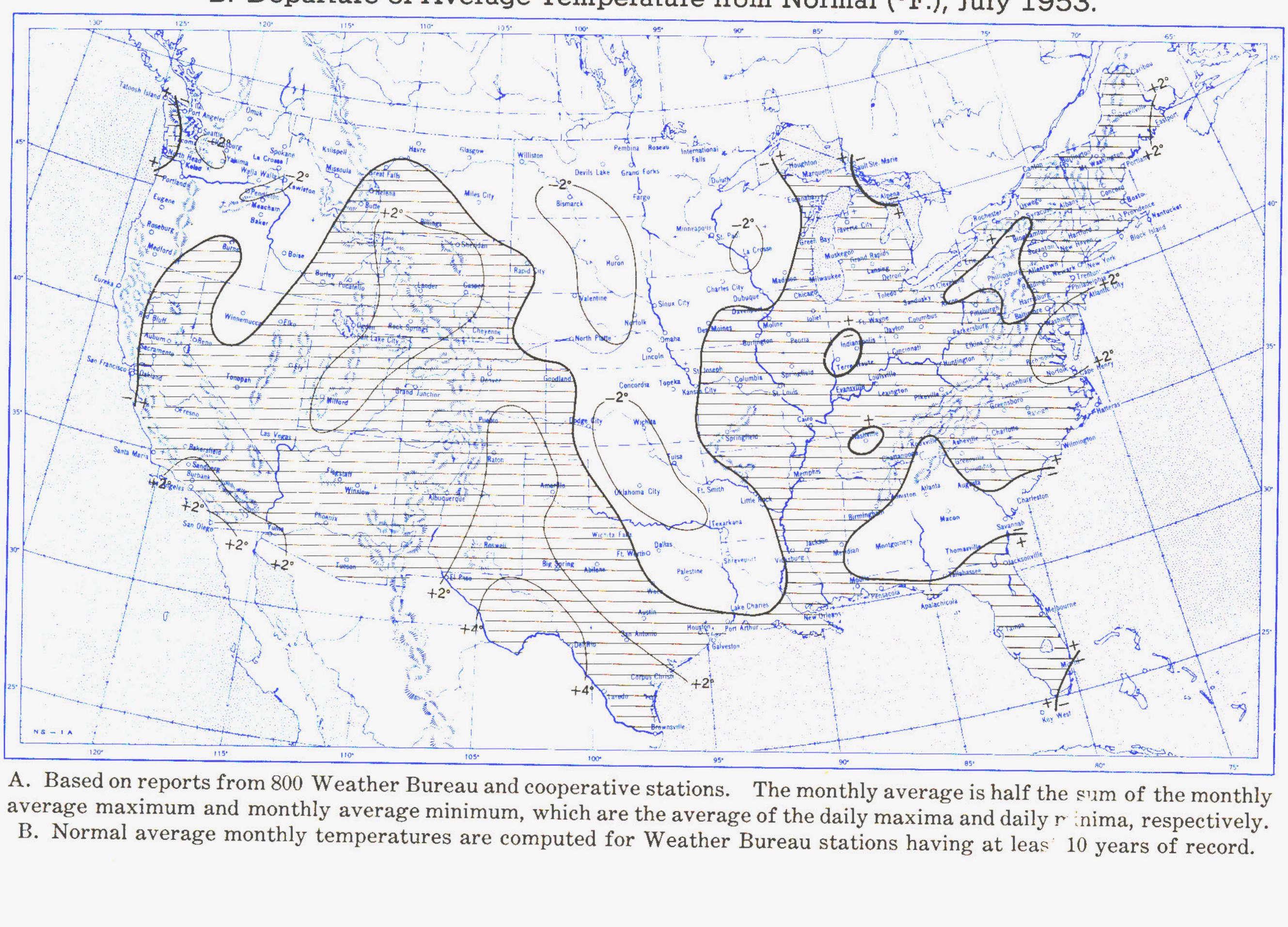
REFERENCES

1. Jay S. Winston, "The Weather and Circulation of June 1953—The Second Successive June With Record-Breaking Drought and Heat," *Monthly Weather Review*, vol. 81, No. 6, June 1953, pp. 162–168.
2. Thomas R. Reed, "The North American High-Level Anticyclone," *Monthly Weather Review*, vol. 61, No. 11, Nov. 1933, pp. 321–325.
3. Obie Y. Causey, "The Distribution of Summer Showers Over Small Areas," *Monthly Weather Review*, vol. 81, No. 4, Apr. 1953, pp. 111–114.
4. J. Namias and P. F. Clapp, "Confluence Theory of the High Tropospheric Jet Stream," *Journal of Meteorology*, vol. 6, No. 5, Oct. 1949, pp. 330–336.

Chart I. A. Average Temperature (°F.) at Surface, July 1953.

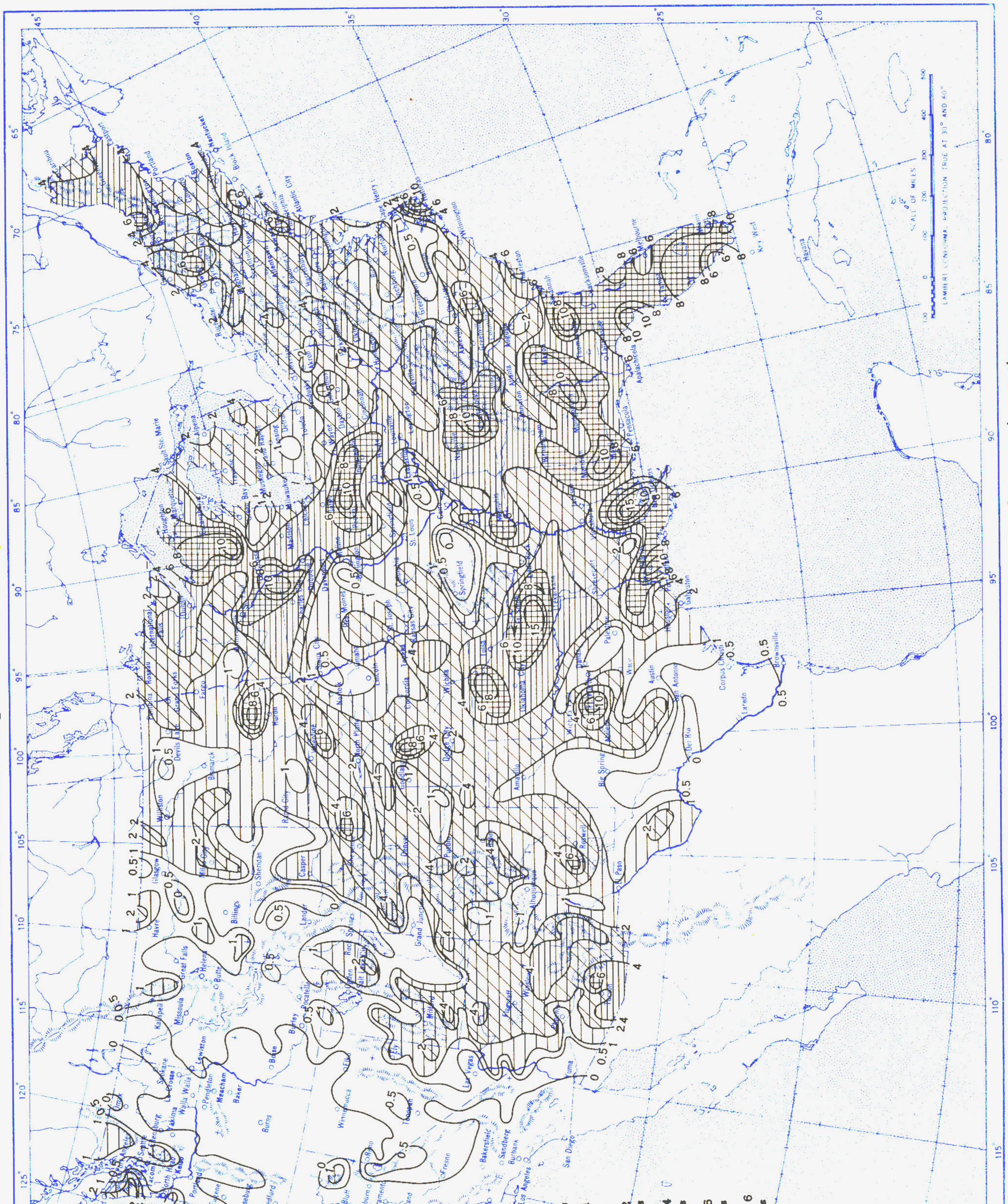


B. Departure of Average Temperature from Normal (°F.), July 1953.



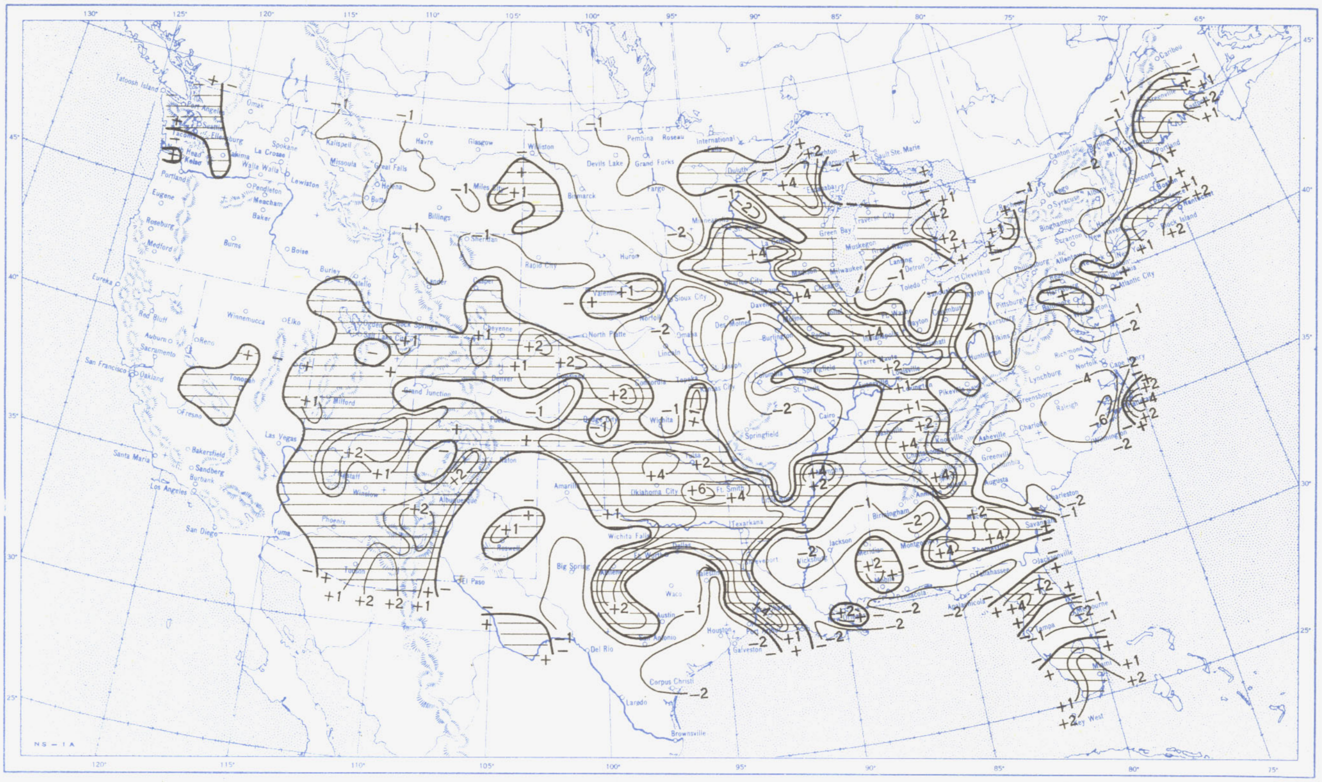
A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.
B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.

Chart II. Total Precipitation (Inches), July 1953.

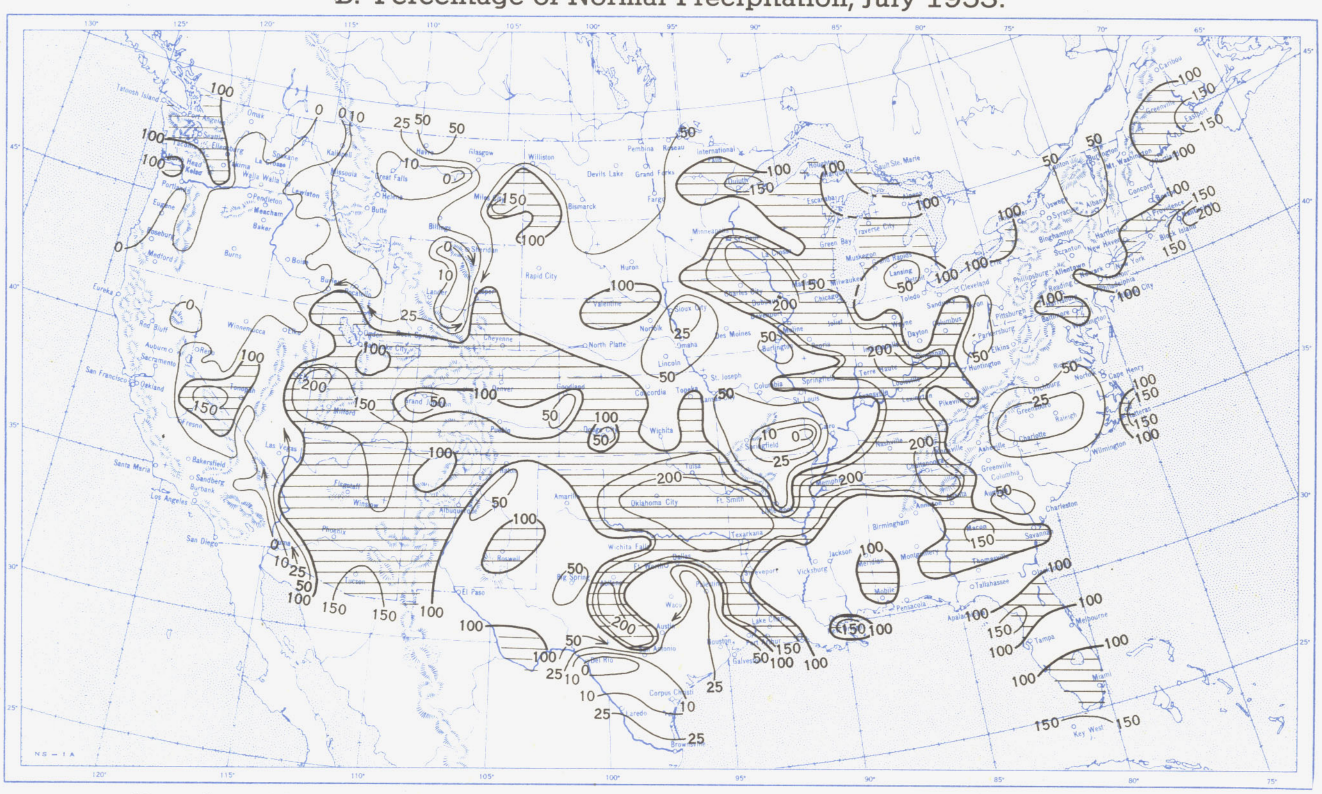


Based on daily precipitation records at 800 Weather Bureau and cooperative stations.

Chart III. A. Departure of Precipitation from Normal (Inches), July 1953.

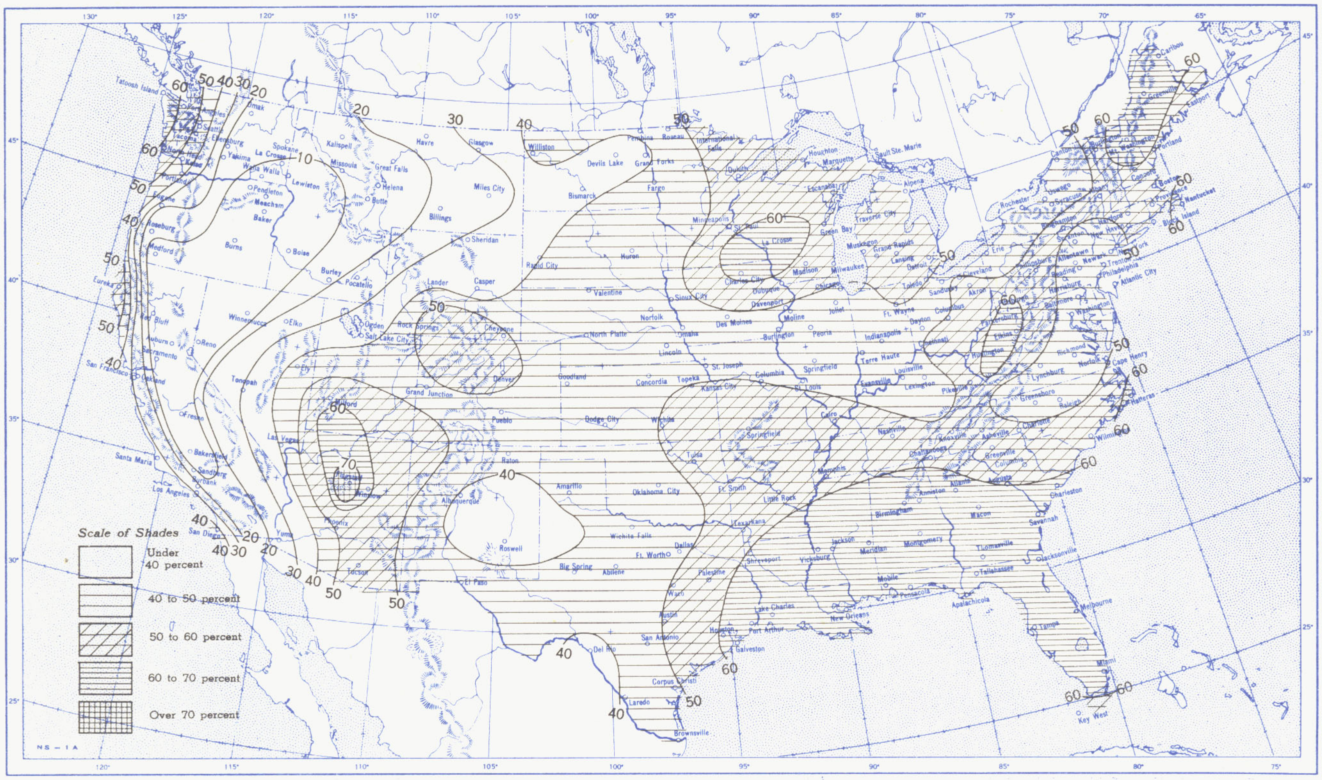


B. Percentage of Normal Precipitation, July 1953.

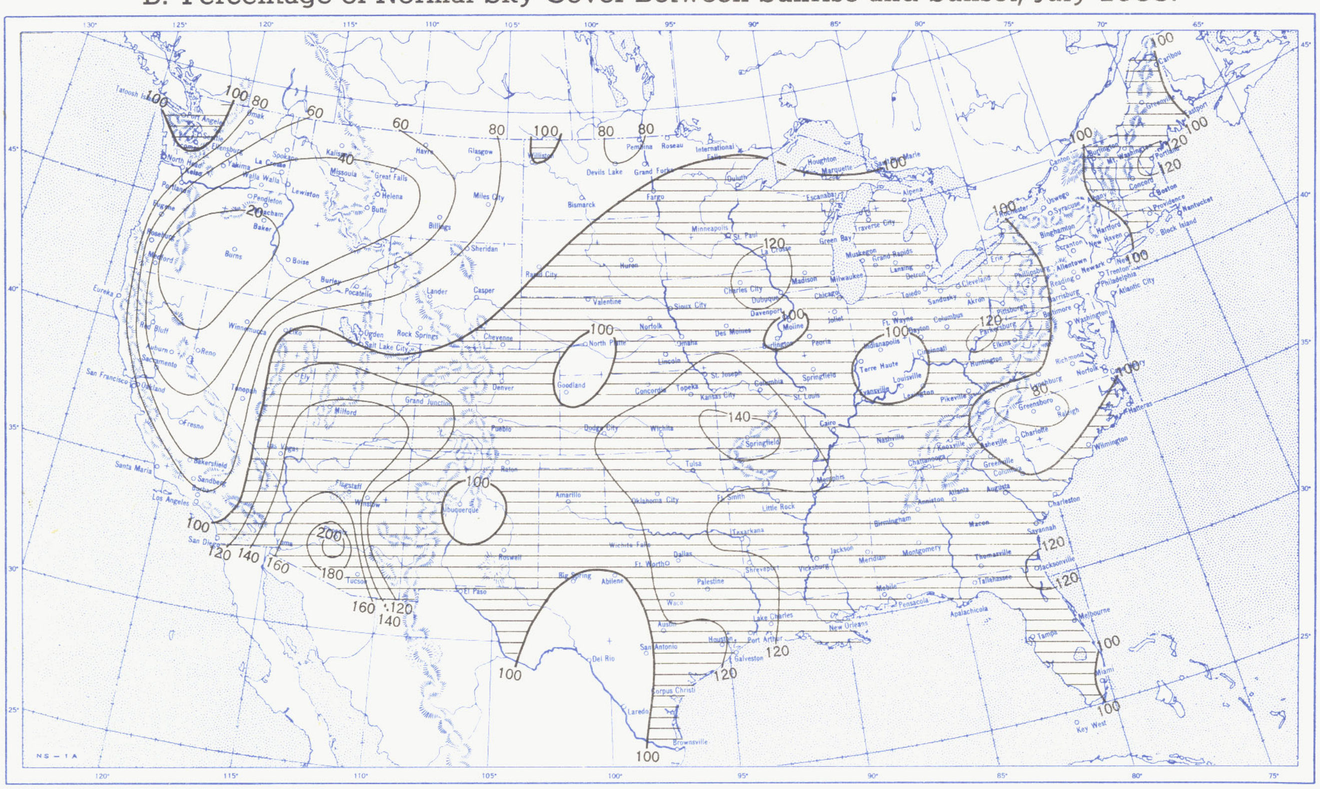


Normal monthly precipitation amounts are computed for stations having at least 10 years of record.

Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, July 1953.

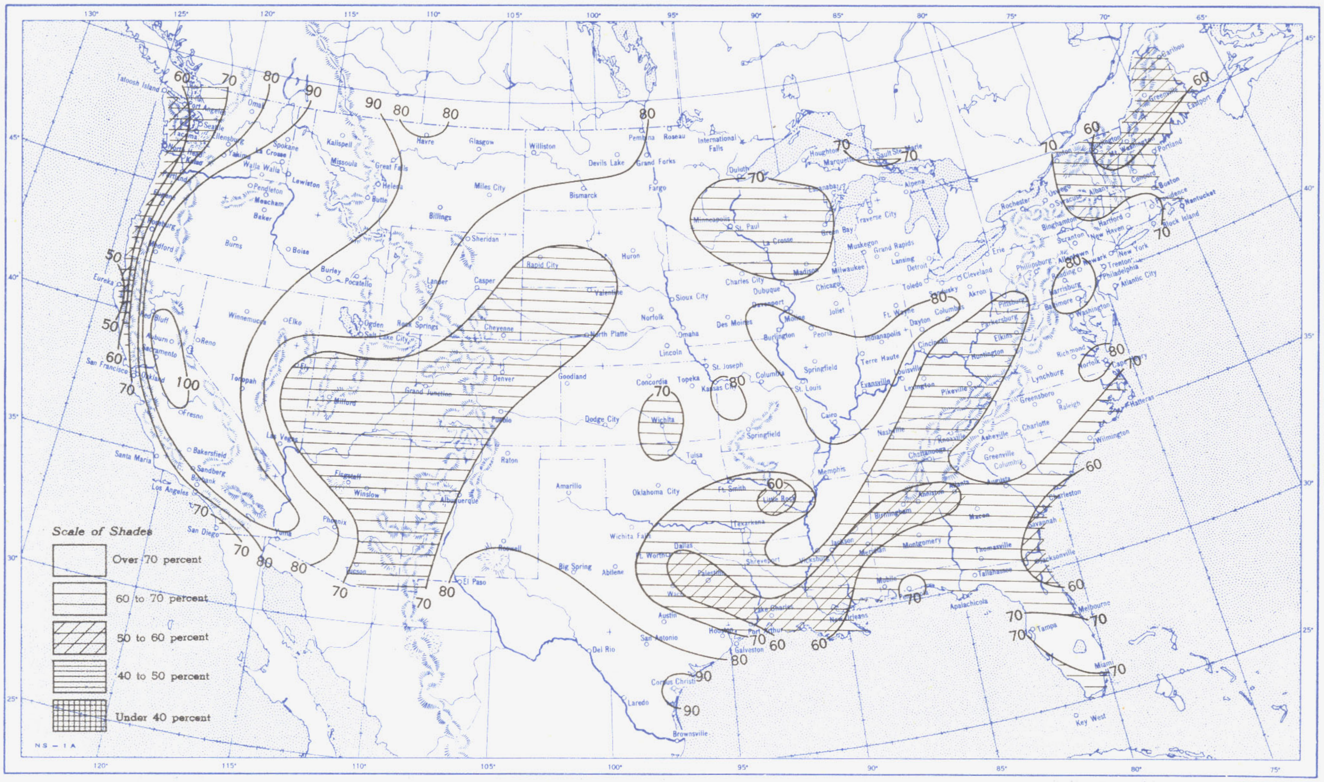


B. Percentage of Normal Sky Cover Between Sunrise and Sunset, July 1953.

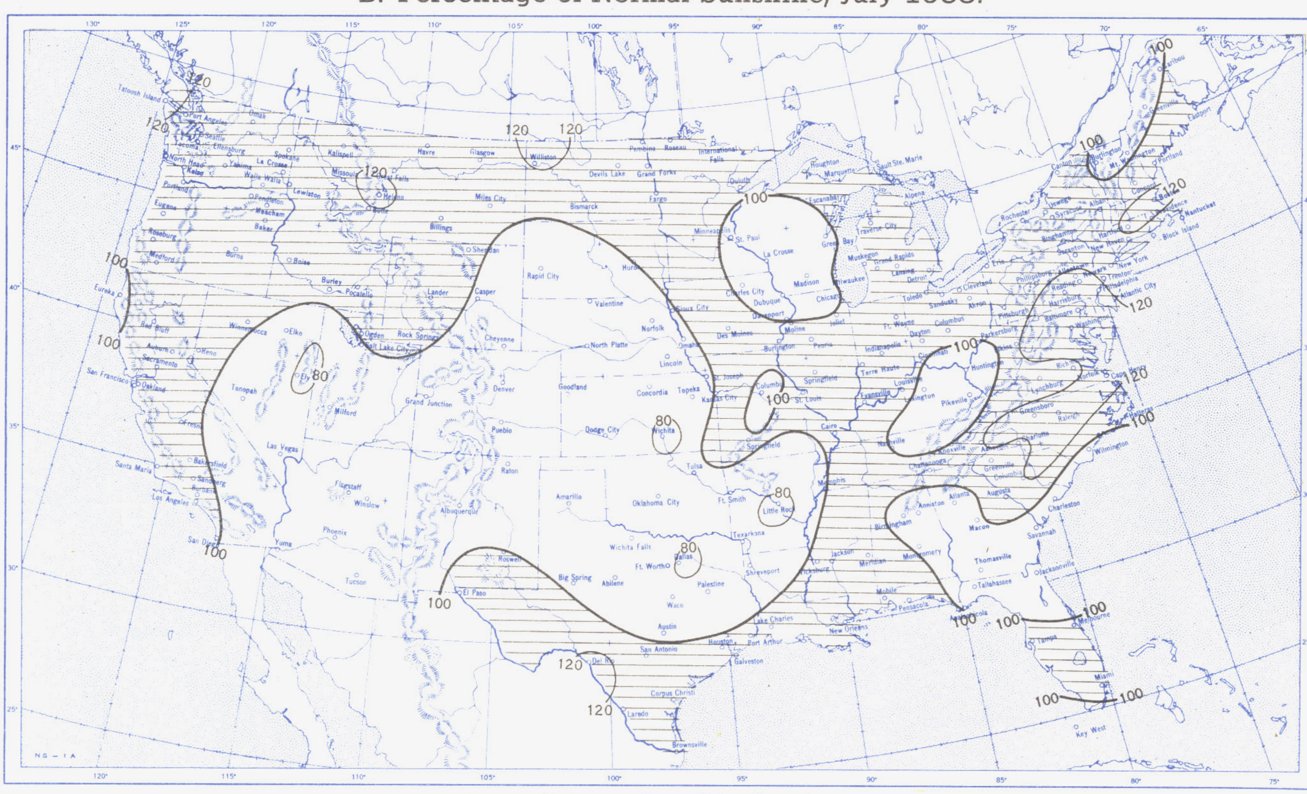


A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.

Chart VII. A. Percentage of Possible Sunshine, July 1953.



B. Percentage of Normal Sunshine, July 1953.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.

Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, July 1953. Inset: Percentage of Normal Average Daily Solar Radiation, July 1953.

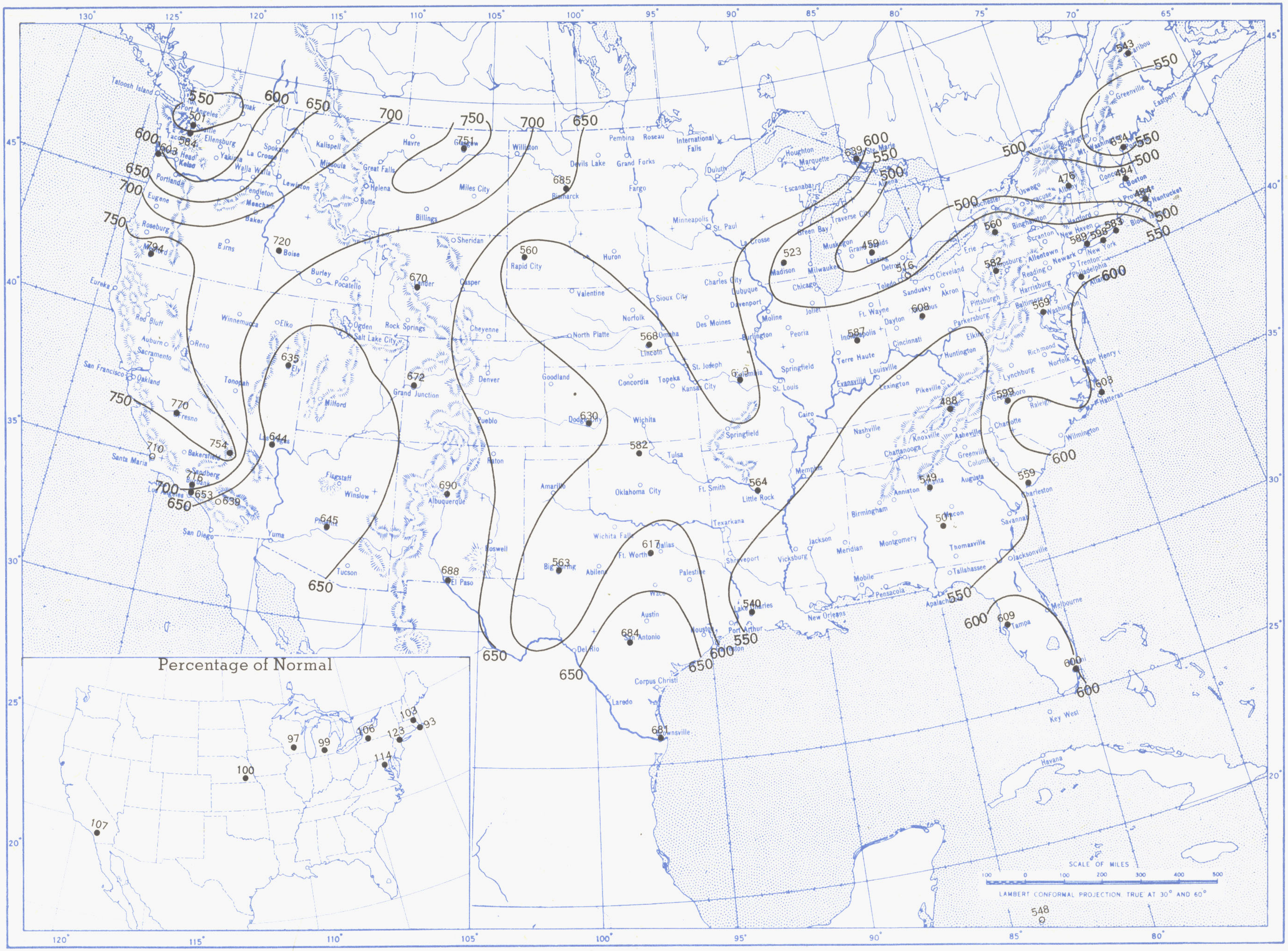
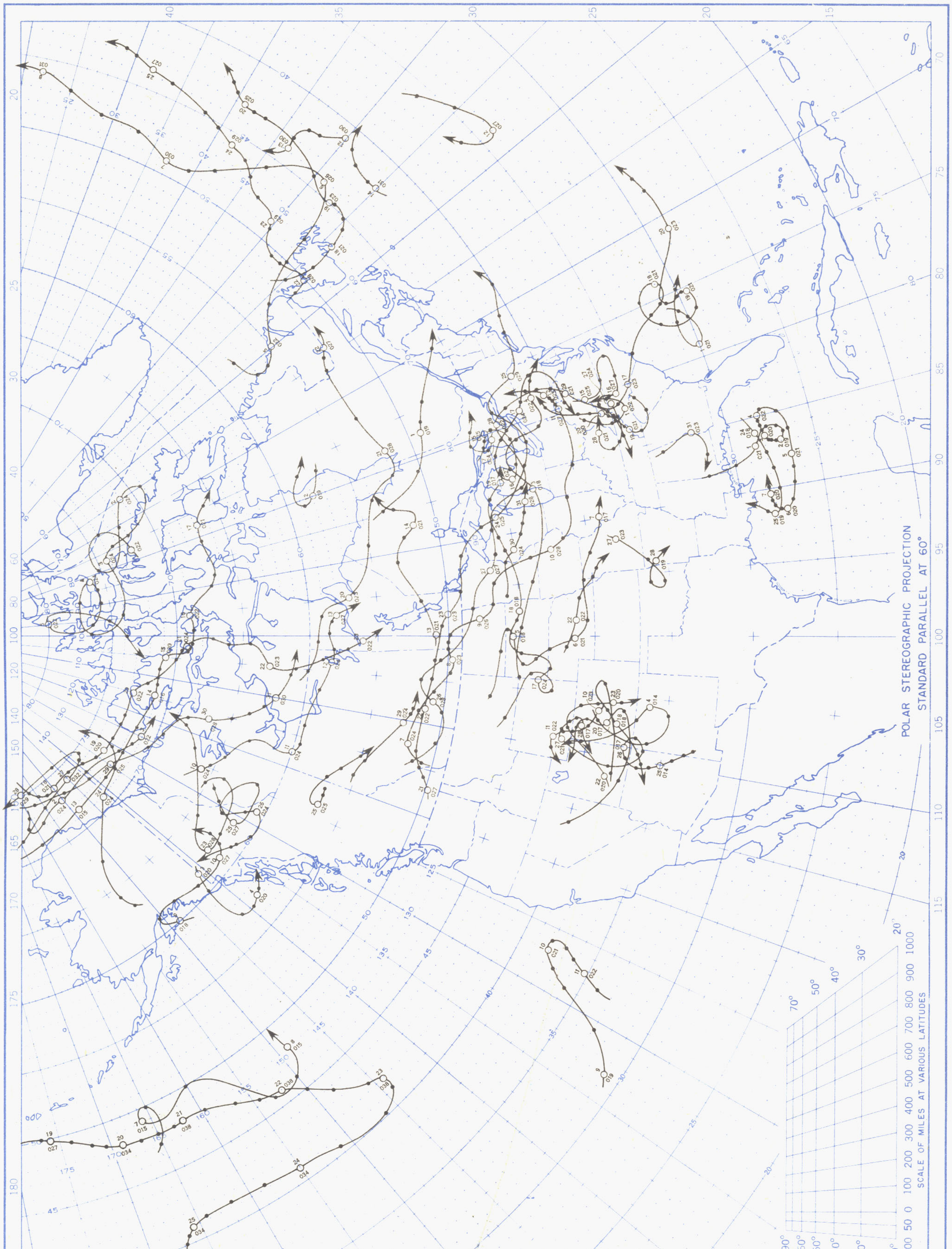


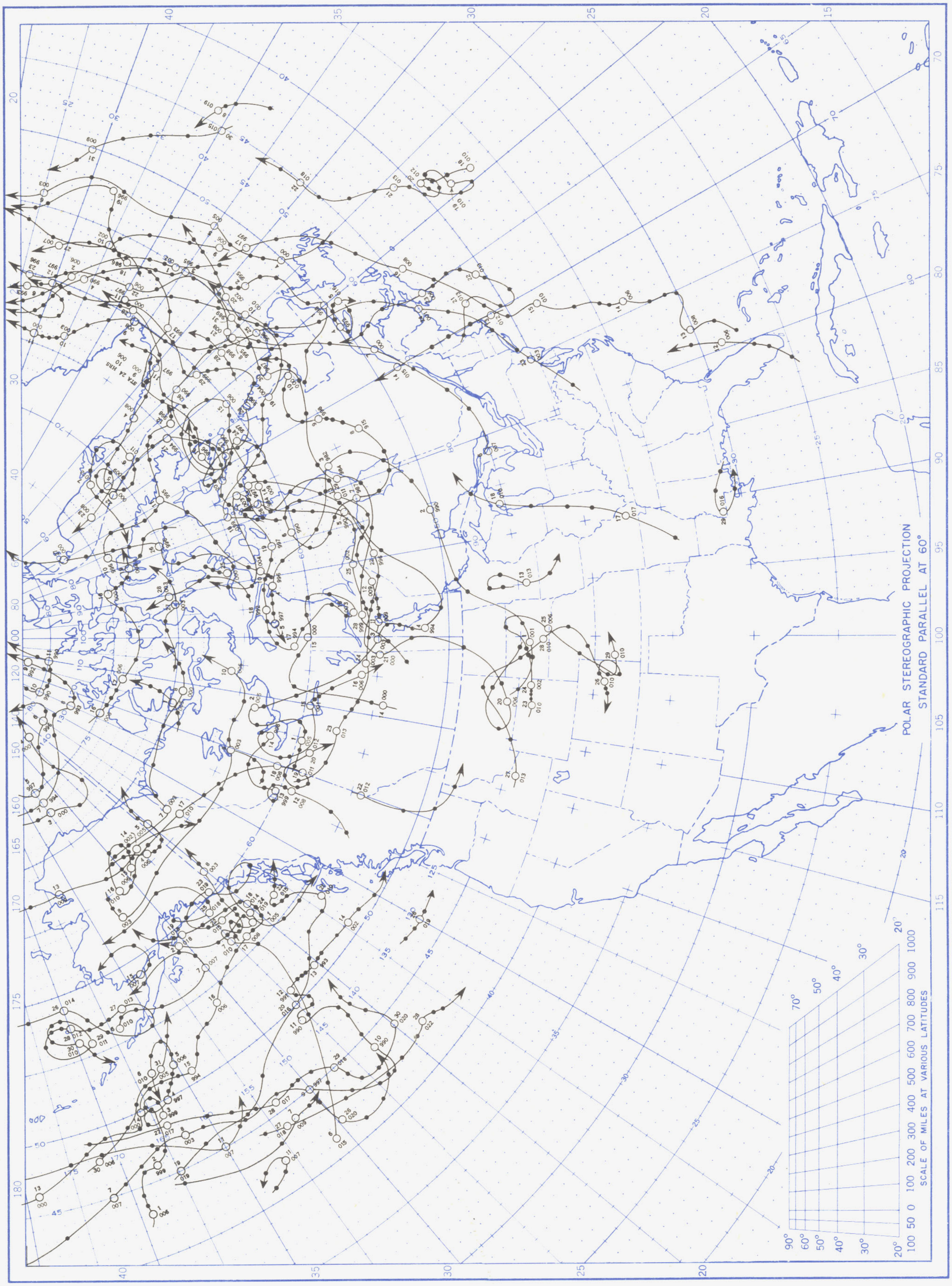
Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langleys (1 langley = 1 gm. cal. cm. $^{-2}$). Basic data for isolines are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.

Chart IX. Tracks of Centers of Anticyclones at Sea Level, July 1953.



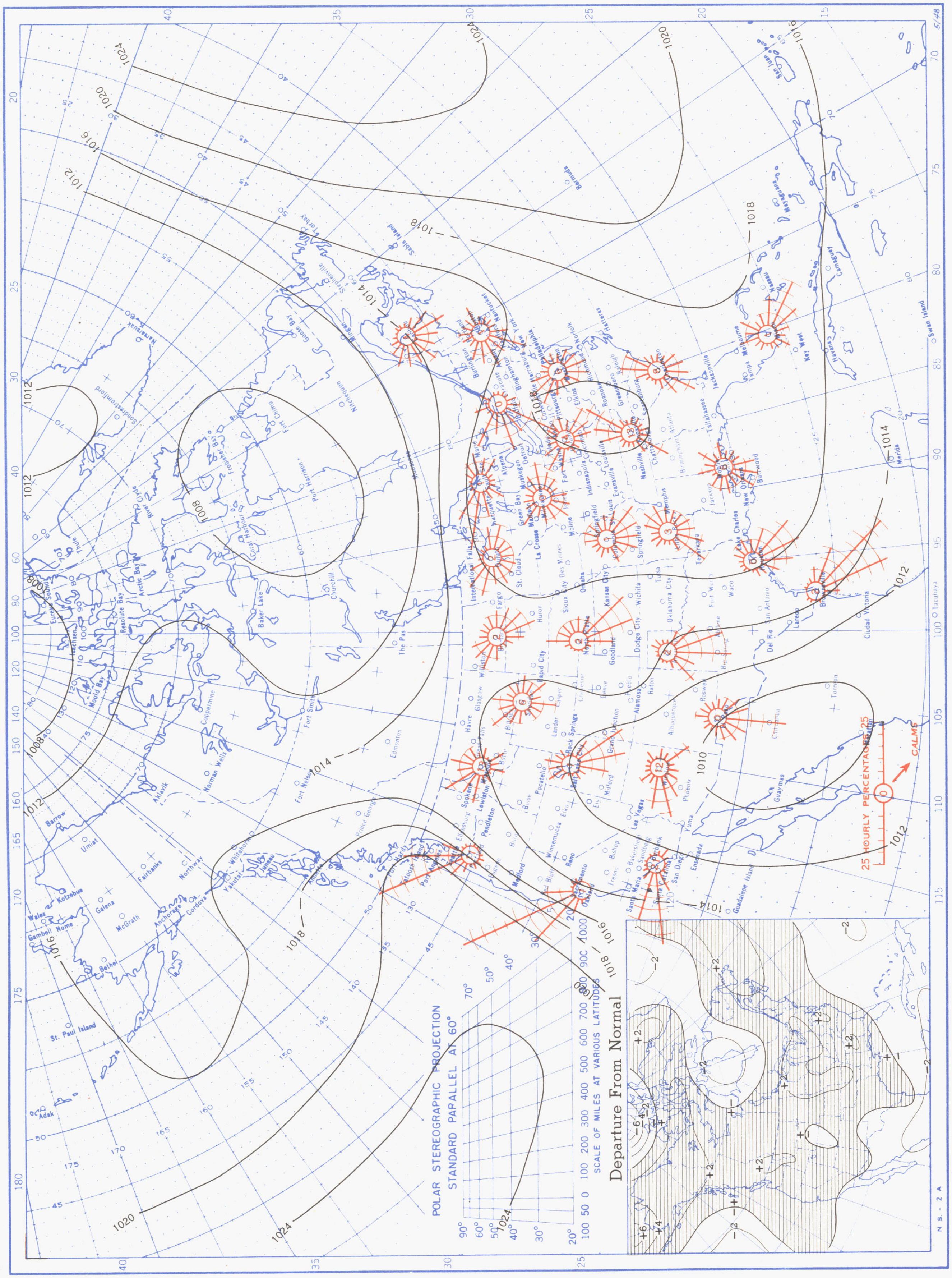
Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.

Chart X. Tracks of Centers of Cyclones at Sea Level, July 1953.



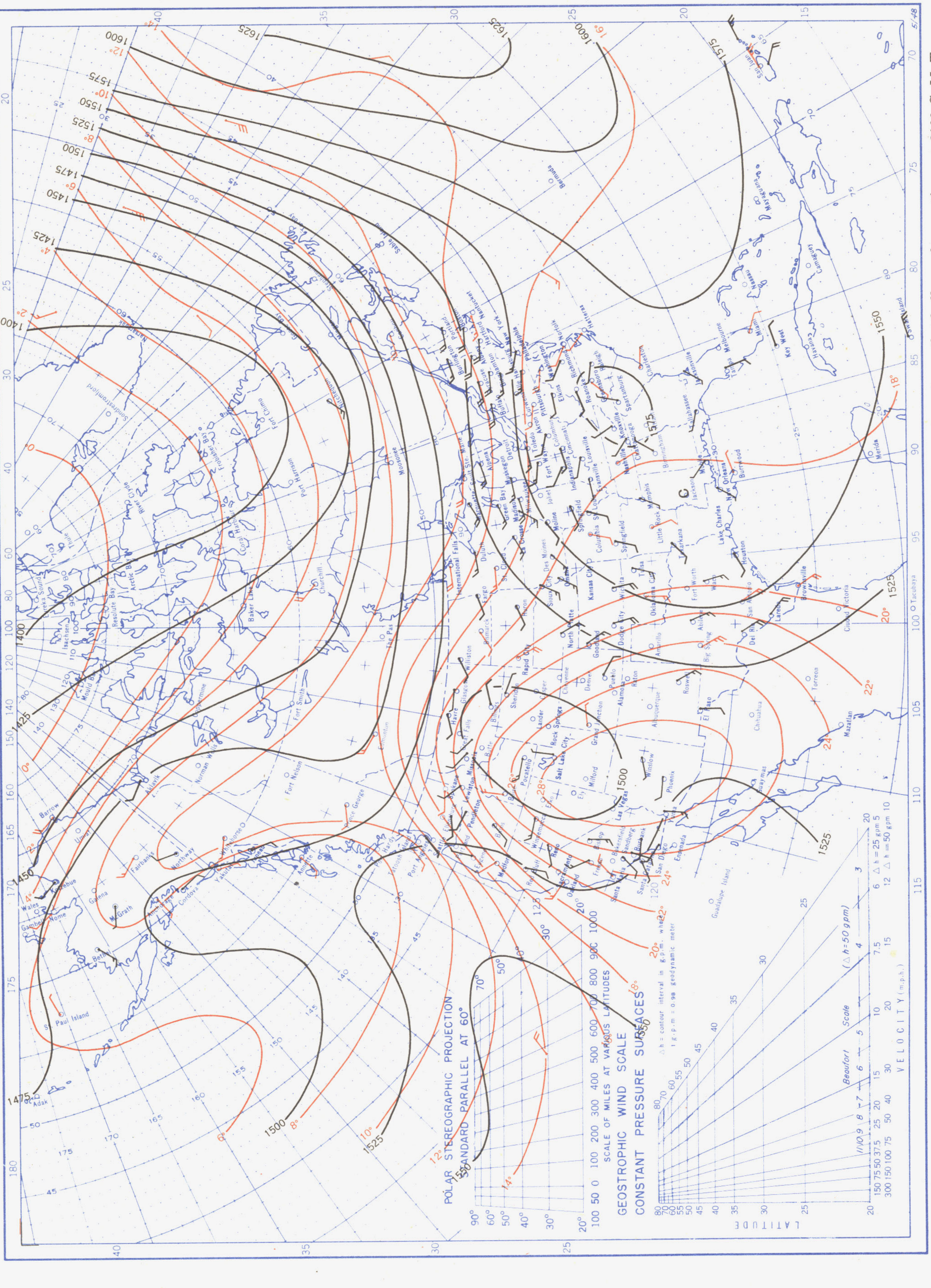
Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.

Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, July 1953. Inset: Departure of Average Pressure (mb.) from Normal, July 1953.



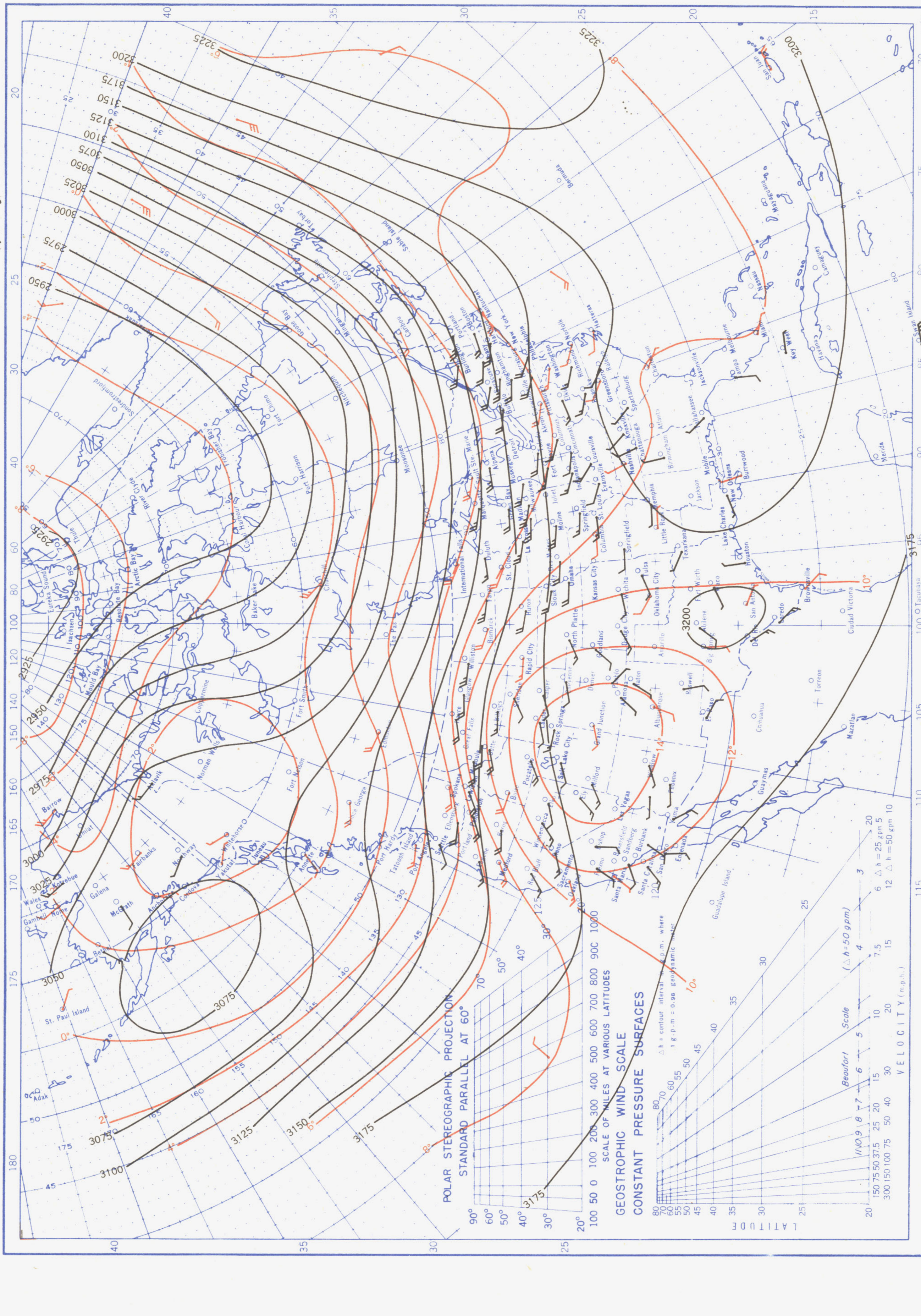
Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° intersections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.

Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), July 1953.



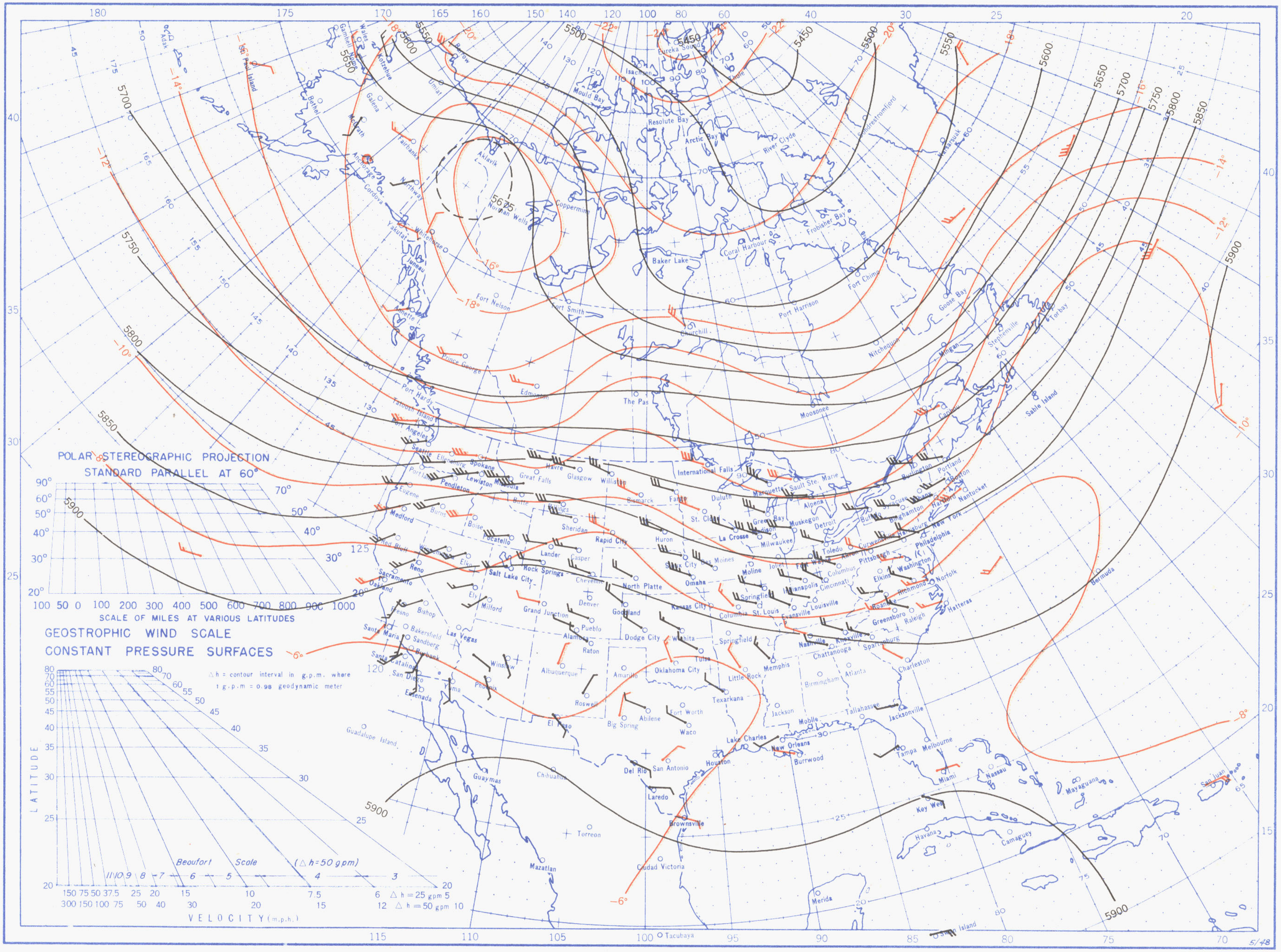
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), July 1953.



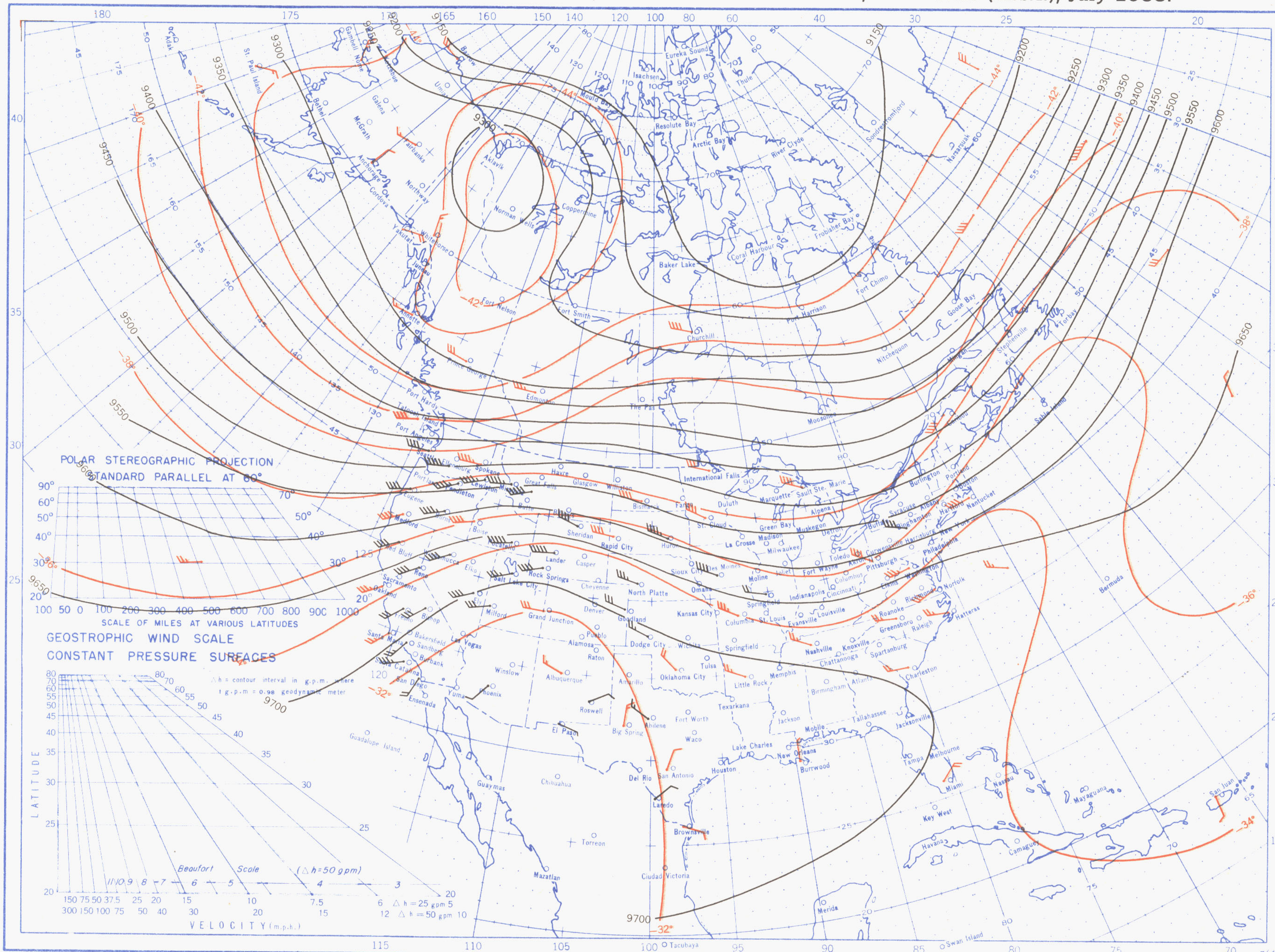
Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.

Chart XIV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 500-mb. Pressure Surface, Average Temperature in °C. at 500 mb., and Resultant Winds at 5000 Meters (m.s.l.), July 1953.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.

Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), July 1953.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.